International Journal of Metallurgical & Materials Science and Engineering (IJMMSE)
ISSN(P): 2278-2516; ISSN(E): 2278-2524
Vol. 6, Issue 2, Apr 2016, 1-6

EFFECT OF ANNEALING ON LOW CARBON STEEL GRADE 1008

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ABSTRACT

This work was focused on the mechanical characteristics and the effects of annealing temperatures on mechanical properties to low carbon steel grade 1008 like impact, hardness, microstructure, and compression strength. The specimens were prepared by using a turning machine, and electric furnace.

The value of impact test to specimen before annealing was (17.85J). The value of impact energy increased when temperature is increased and the maximum increase was 46.21%, achieved at 950 C. In a compression test it was found that the value of compression increased when temperature was increased and the maximum increase was 4.34%, achieved at 950 C. Compression test values for the first four temperatures were less than compression test to specimen before annealing.

The percentage between initial value of compression test and minimum value at 830 C is -16.52%. It was found that the value of hardness decreased when the temperature increases and the maximum decrease is -28.9% achieved at 950 C.

KEYWORDS: Hardness, Low Carbon Steel, Compression

Received: Feb 24, 2016**; Accepted:** Mar 09, 2016**; Published:** Mar 21, 2016**; Paper Id.:** IJMMSEAPR20161

Original Article

INTRODUCTION

Heat treatment operation is a means of controlled heating and cooling of materials in order to Effect changes in their mechanical properties. Heat treatment is also used to increase the strength of materials by altering some certain manufacturability objectives especially after the materials might have undergo major stresses like forging and welding [1].

Investigated the effects of recrystallization annealing temperature on carbide precipitation, microstructure, and mechanical properties in Fe-18Mn-0.6C-1.5Al TWIP steel the coarsening rate of recrystallized grains was observed to increase while the Rockwell hardness greatly decreased for the material [2].

Over 500 million tones of low carbon steels are produced yearly around the world; they are used for most of the engineering applications. Low carbon steels are utilized to produce cars body panels, tubes, domestic appliance side panels and other engineering applications because they are readily available, workable and weld able [3]

The findings of also revealed that, amongst various heat treatment processes (hardening, annealing, normalizing tempering, etc.) , annealing causes softening of the steel followed by a resulting increase in ductility and relief of residual stresses. It is of necessity to note that all the different heat treatment processes consists of three stages: heating of the material, holding the temperature for a stipulated period and cooling, generally to room

temperature [4].

The mechanical properties of any structural metallic material - with certain chemical composition - are functions of its micro- structure. So the aim of any heat treatment technology is the improvement, or control of the mechanical properties by controlling the microstructure to suit the requirements restricted on a certain piece, even for use, or for subjecting to a forming or machining technology [5].

Heat treatment for carbon steel is used to improve the mechanical properties of the steel. These properties include the yield strength, toughness, ductility, hardness and impact strength [6].

The annealing of cold work steel has been a subject of investigations. These studies have been concerned with kinetics of recrystallization, with microstructure and texture development and with the individual and combined effects of composition, thermal history prior to cold work and heating rates during subsequent annealing. Time was considered the important parameter in the procedures of most of these studies [7].

Heat treatment is a combination of timed heating and cooling applied to a particular metal or alloy in the solid state in such ways as to produce certain microstructure and desired mechanical properties (hardness, toughness, yield strength, ultimate tensile strength, Young’s modulus, percentage elongation and percentage reduction). Annealing, normalizing, hardening and tempering are the most important heat treatments often used to modify the microstructure and

Mechanical properties of engineering materials particularly steels Annealing is the type of heat treatment most frequently applied in order to soften iron or steel materials and refines its grains due to ferrite-pearlite microstructure; it is used where elongations and appreciable level of tensile strength are required in engineering materials [8].

EXPERIMENTAL PROCEDURE

Material

Low carbon steel is now the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications

Table 1: The Chemical Composition of Low Carbon Steel

C%	Si %	Mn %	P %	S %	Mo %	Cu%	N %	V %
0.09	0.09	0.43	0.009	0.027	0.01	0.3	0.009	0.001

Annealing Process

The purpose of this process is to enhance toughness and reduce hardness.

This cycle involves three phases:

- Heating the steel to upper critical Temperature.
- Holding time.
- Cooled in the furnace.

Table 2: Temperature and Holding Times for Annealing Process of Type .B Specimens

Carbon Steel	Annealing Temperature (C)	Holding Time (Min)
A	830	25
B	860	25
C	890	25
D	920	25
E	950	25

Table 3: Temperature and Holding Times for Annealing Process of Type Specimens

Carbon Steel	Annealing Temperature (C)	Holding Time (min)
A	830	15
B	860	15
C	890	15
D	920	15
E	950	15

COMPRESSION TEST

Compression test was used to determine the behavior of materials under crushing loads. Specimens of (10mm) in diameter and (25mm) in height are compressed and deformation at various loads.

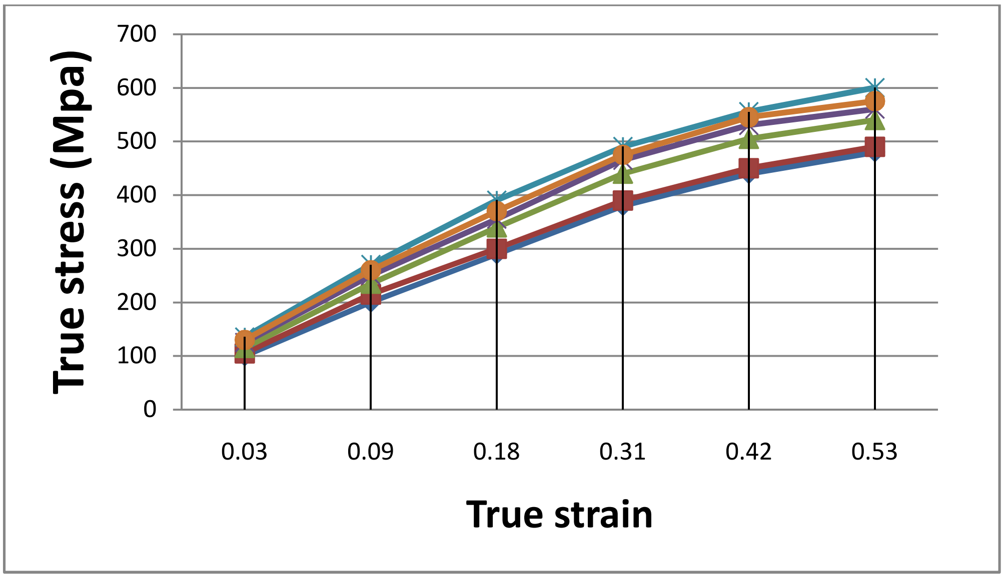

Figure 1: Effect of Annealing Temperature on the Mechanical Behavior of Low Carbon Steel under Stress

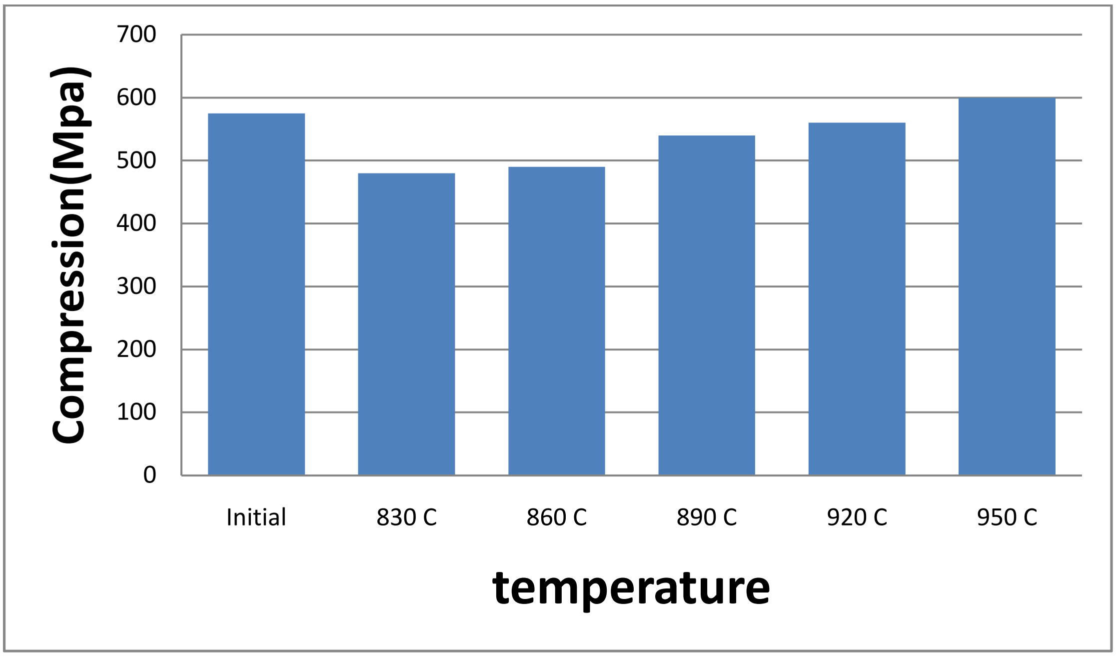

Figure 2: Effect of Annealing Temperature on the Compression of Low Carbon Steel and its Regimes

IMPACT TEST

The purpose of impact testing is to measure an object's ability to resist high-rate loading. Charpy bar test pieces (10*4*55 mm3) containing V-Notch, where machined using CNC machine. Two specimens of each regime were tested to ensure the repeatability from which the average is calculated.

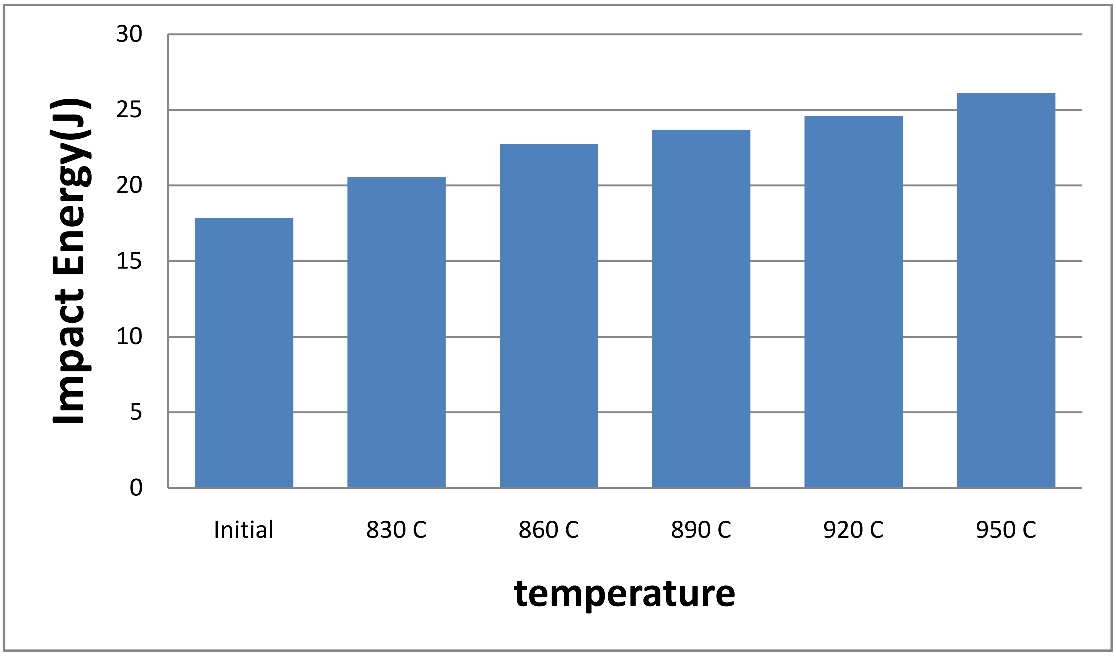

Figure 3: Effect of Annealing Temperature on the Impact Energy of Low Carbon Steel and Its Regimes

HARDNESS TEST

Micro hardness test was carried out on each specimen at 60 KgF using micro hardness tester type (Rockwell), six readings were taken then the average was calculated for each sample.

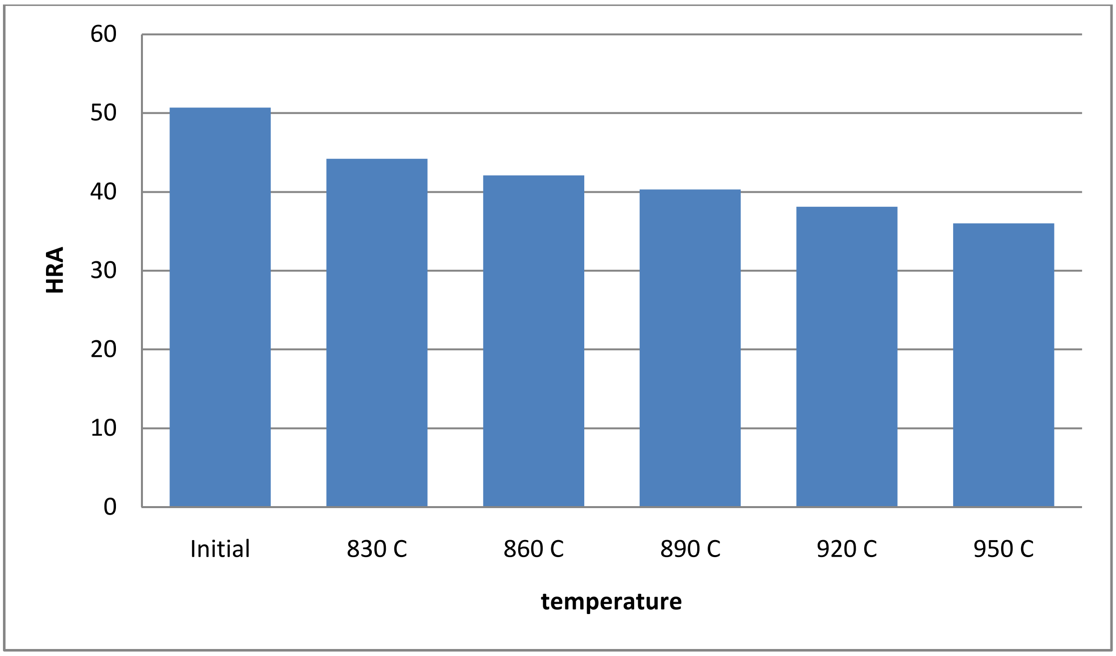

Figure 4: Effect of Annealing Temperature on the Hardness of Low Carbon Steel and its Regimes Microstructure Test

Microstructure is the small scale structure of material, defined as the structure of a prepared surface of material as revealed by a microscope above 25x magnification.

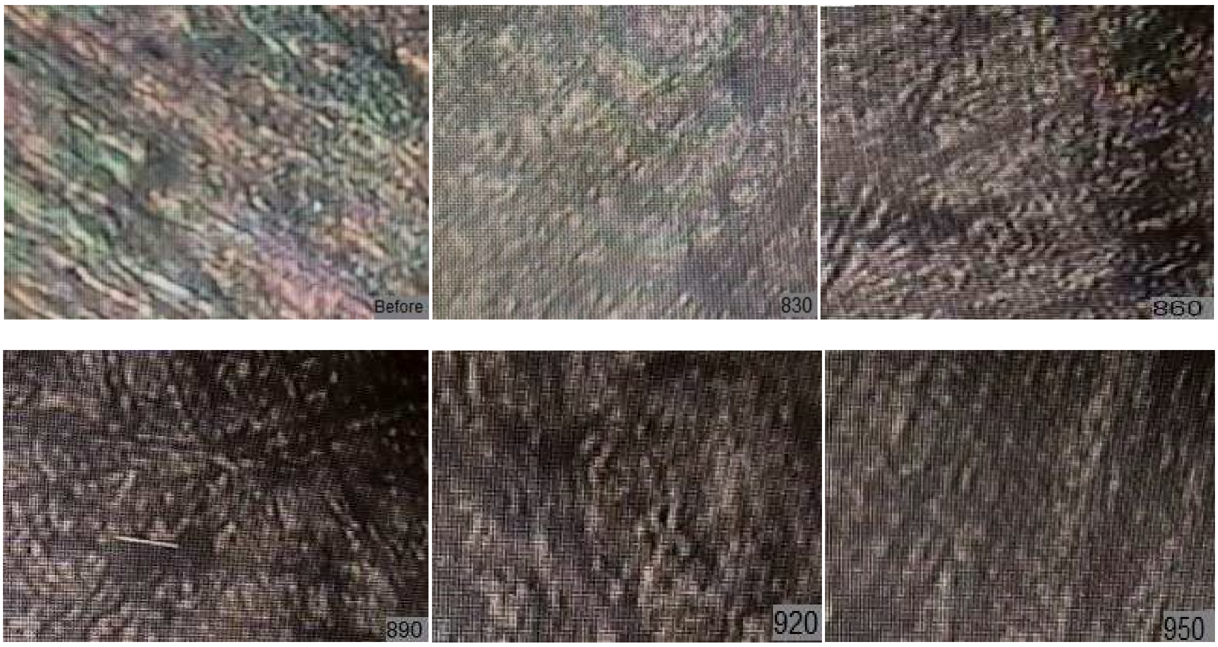

Figure 5: Photomicroscan of Carbon Steel before and After Annealing at 160x

The carbon content increased above the grain boundary when the annealing temperatures increased. In addition, an increase in the grain size occurred when temperature increased.

CONCLUSIONS

The following points can be concluded:

- The impact toughness generally increased as the annealing temperature increased, the maximum increase was 46.21% at 950 C.
- The compression stress generally increased as the annealing temperature increased, the maximum increase was 4.34% at 950 C.
- In compression stress test the percentage difference between initial value and minimum value was -16.52% at 830 C.
- In hardness test the value of hardness increase when the annealing temperature is decrease and the maximum decrease is -35.8% at 950 C.
- The ferrite increased above grain boundary when the annealing temperature was increased, in addition to an increase in the grain size.

REFERENCES

1. *Adnan, Calik. Effect of cooling rate on Hardness and Microstructure of AISI 1020, AISI 1040 and AISI 1060 Steels. Int J of Physics Sciences, vol. 4(9), pp. 514 – 518, 2009.*
2. *S. Kang, Y. S. Jung, J. H. Jun and Y. K. Lee, "Effect of Recrystallization Annealing Temperature on Carbide Precipitation, Microstructure and Mechanical Properties in Fe-18Mn-0.6C-1.5Al TWIP Steel," Materials Science and Engineering: A, Vol. 527, No. 3, 2010, pp. 745-751.*
3. *Fish P. M. Woodhead Pub. Ltd., Cambridge, (1995).*
4. *Offor P. O., Daniel C. C., Obikwelu D. O. N. Nig. J. Tech. 29 (2010) 76.*
5. *J. Prohászka, J. Dobránszky, Quality Improvement of Low Carbon Reinforcing Steel by Rapid Heat Treatment, J. Heat Treating, Vol. 9, No. 1, 1991, p 63-67., Springer Verlag, New York Inc.*
6. *J. B. Broome, "Development of a Robust Heat Treatment Process for Rockwell B-Scale Hardness Test Blocks," Master's Thesis, Massachusetts Institute of Technology, 1997.*
7. *J. W. Lee, J. C. Lee, Y. S. Lee, K. T. Park and W. J. Nam, "Effect of Post-Deformation Annealing Conditions on the Behavior of Lamella Cementite and Occurrence of Delamination in Cold Drawn Steel Wires," Journal of Materials Processing Technology, Vol. 209, No. 12-13, 2009, pp. 5300-5304.*
8. *Raymond A., Higgins B., 1985, Properties of Engineering Materials. Hoodder and Stonghton.*